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<u>L10</u>	l8 and L9	1	<u>L10</u>
<u>L9</u>	(benzobisoxazole adj fib\$) and L1	1	<u>L9</u>
<u>L8</u>	resorcinol and L7	8	<u>L8</u>
<u>L7</u>	(latex adj adhesive) and L6	11	<u>L7</u>
<u>L6</u>	latex and L5	28	<u>L6</u>
<u>L5</u>	(epoxy adj compound\$) and L3	28	<u>L5</u>
<u>L4</u>	(resorcinol-formalin-latex adj adhesive) and L3	1	<u>L4</u>
<u>L3</u>	cord and L1	800	<u>L3</u>
<u>L2</u>	(poly-p-phenylene adj benzobisoxazole adj fib\$) and L1	0	<u>L2</u>
<u>L1</u>	(transmission adj belt\$)	3782	<u>L1</u>

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<u>L6</u>	latex and L5	28	<u>L6</u>
<u>L5</u>	(epoxy adj compound\$) and L3	28	<u>L5</u>
<u>L4</u>	(resorcinol-formalin-latex adj adhesive) and L3	1	<u>L4</u>
<u>L3</u>	cord and L1	800	<u>L3</u>
<u>L2</u>	(poly-p-phenylene adj benzobisoxazole adj fib\$) and L1	0	<u>L2</u>
<u>L1</u>	(transmission adj belt\$)	3782	<u>L1</u>

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L8: Entry 7 of 8

File: USPT

Dec 27, 1988

DOCUMENT-IDENTIFIER: US 4794041 A

TITLE: Activation of polyethylene terephthalate materials for improved bonding to adhesives

Brief Summary Text (3):

As discussed in U.S. Pat. Nos. 3,419,463; 3,729,336; and 3,755,165 regarding the manufacture of rubber goods requiring cord reinforcement, such as in pneumatic tires, friction belts and the like, the strength and durability of the adhesive bond between the reinforcing cord and the rubber being reinforced is important. The reinforcing cord serves to increase the tensile strength of the rubber-based goods and restrict the degree of distortion during use. The reinforcing cord is normally placed within the rubber mass and must be firmly bonded to the rubber to provide a unitary structure. Stress will occur at the interface between the reinforcing element and the rubber during use. Accordingly, good bond strength and adhesion is needed to prevent separation at the interface.

Brief Summary Text (4):

Polyester reinforcing materials are increasingly being employed in the reinforcement of such rubber-based goods, and particularly as tire cord, in the manufacture of rubber tires. These polyester reinforcing materials (e.g., polyethylene terephthalate filament or cord) possess physical characteristics such as high strength, flex resistance, high stretching modulus and low creep which make them outstanding materials for such reinforcement. However, the use of polyester reinforcing materials in rubber reinforcement applications is subject to certain problems due to the poor rubber adhesion properties associated with unmodified polyester materials.

Brief Summary Text (5):

The use of aqueous dispersions containing a combination of a resorcinol-formaldehyde condensate and an elastomer latex (referred to as an RFL dip) is best known as an effective treating agent for improving the rubber adhesion of some synthetic polymer reinforcing materials such as nylon. However, the RFL dips do not satisfactorily overcome the problems encountered with the adhesion of unmodified polyester reinforcing materials due to the low level of reactive functional groups in such materials (e.g., polyethylene terephthalate).

Brief Summary Text (6):

Attempts have been made to find new treating agents to improve the rubber adhesion of polyester reinforcing materials or, in the alternative, to treat the polyester with additional agents in combination with the RFL dip treatment to improve the adhesion. For example, U.S. Pat. No. 3,383,242 discloses pretreatment of polyethylene terephthalate yarn by use of an aqueous dispersion of a curable combination of a diglycidic ether of an aliphatic diol and an amine curing agent and a water-dispersible lubricating agent. U.S. Pat. No. 3,755,165 discloses a tire yarn finish composition consisting of a lubricating oil, an antistatic agent, an emulsifier, water and as an adhesive promoting agent an aliphatic diisocyanate. U.S. Pat. No. 3,834,934 discloses an adhesive composition for fibrous material comprising an admixture of RFL and a triallyl cyanurate-resorcinol-formaldehyde reaction product. U.S. Pat. No. 3,729,336 discloses treatment of polyester fibers with a composition of a copolymer comprising crystallizable ester units identical to those in the polyester fiber, poly-oxyalkylene groups and polyepoxy containing groups and a polyepoxide followed by application of RFL. U.S. Pat. No. 4,031,288 discloses

pretreatment of tire cord with a solvent solution of a polyisocyanate followed by application of an adhesive such as RFL. U.S. Pat. No. 4,187,349 discloses an adhesive system for polyester tire cord comprising a heat-curable admixture of a polyepoxide and a linear carbon-to-carbon addition polymer containing pendent aminimide and N-pyrrolidonyl groups.

Brief Summary Text (9):

Although many of these prior art treatments increase the adhesion between the polyester and the rubber, in the case of polyethylene materials having a reduced carboxyl group content to improve the hydrolytic stability of the yarn, the adhesion to rubber is in many cases insufficient especially if reduced curing temperatures for the resorcinol-formaldehyde-latex RFL are used.

Brief Summary Text (19):

In accordance with the present invention, a polyethylene terephthalate material is activated with an electron beam to enhance the adhesion of the material to a suitable rubber adhesive such as an epoxy or isocyanate adhesive. Such activation results in the formation of free radicals which, under ambient conditions, are permitted to form carboxyl and hydroxyl functional groups which react with the applied adhesive. Such polyethylene terephthalate materials may take many forms including but not being limited to filaments, fibers, threads, yarns, cords, etc.

Brief Summary Text (22):

The spin finish may contain an antistatic agent to reduce the electrostatic charge of the filament during its processing into a cord or fabric. Useful agents include cationic compounds containing a quaternary ammonium-, pyridinium-, imidazolinium-, and quinolinium function, and phosphated alcohols, ethyloxated amides, and the like.

Brief Summary Text (33):

Once the carboxyl and hydroxyl functionalities are formed, the adhesive may be applied to the polyethylene terephthalate. With reference to the adhesive, any of the adhesive compositions which are reactive to carboxyl and hydroxyl functionalities and which are generally used to bond or adhere polyester fibers to RFL are suitable for use in the present invention. Normally, the polyester in the form of fibers is contacted with a solution, suspension or emulsion of the adhesive composition, as for example, an aqueous or mixed solvent solution or dispersion containing a water-soluble adhesive. Contact is achieved by known means such as dipping, spraying, kiss rolls, etc. Exemplary water-based adhesives suitable for use herein include but are not limited to multifunctional isocyanates, epoxy compounds (which may be multifunctional) or combinations thereof as well as combinations of such adhesives with RFL dips which can be applied either in one dip or in a series of dips. The adhesive is usually present in the overall composition in an amount in the range of from about 1 to 40 percent by weight. However, higher and lower amounts may be used if desired.

Brief Summary Text (38):

An exemplary epoxy resin may be prepared by the condensation of bisphenol A (4,4' isopropylidene diphenol) and epichlorohydrin. Also, other polyols, such as aliphatic polyols and novolak resins (e.g., phenol-formaldehyde resins), acids or other active hydrogen-containing compounds may be reacted with epichlorohydrin for the production of epoxy resins suitable for use in the invention. Exemplary epoxy compounds include multifunctional glycidyl ethers, multifunctional sorbitol epoxy and silane epoxy compounds. The epoxy compounds are preferably applied from solutions containing known basic catalysts for the epoxy group reaction with carboxyl and hydroxyl groups such as inorganic and organic bases. Exemplary epoxy resins are disclosed in U.S. Pat. Nos. 2,902,398 and 3,247,043, each herein incorporated by reference.

Brief Summary Text (45):

As previously discussed, after the at least one adhesive composition has been applied to the activated material, such as tire yarn (or unactivated material which is then activated), a phenolic-aldehyde-latex adhesive may be superimposed on the material. In those instances where the at least one adhesive composition is applied after the material is activated, application of the two types of adhesives may be applied together.

Brief Summary Text (46):

The term "phenolic-aldehyde-latex adhesive" is meant to include phenolic-aldehyde-latex containing compositions which are known and used in the textile and rubber industries for the bonding of polyester fibers to rubber. The phenolic-aldehyde component (e.g., a resole) can be any condensation product of an aldehyde with a phenol which can be heat-cured to form an infusible material. A typical phenolic-aldehyde-latex adhesive composition is a formulation containing resorcinol-formaldehyde resin and a rubber latex such as a styrene-butadiene vinyl pyridine latex (e.g., an RFL adhesive). The preparation of such adhesives is well known in the art and will not be discussed further herein.

Brief Summary Text (47):

The phenolic-aldehyde-latex adhesive is generally applied in a quantity of between about 2 to 20 weight percent (solids retention), based on the weight of the polyester material. The phenolic-aldehyde-latex adhesive is preferably applied after the filament or yarn has been spun into cord or woven into fabric. Preferably, the adhesive-coated material is subjected to a drying and curing treatment, both to eliminate the moisture in the coating and to complete the condensation of the phenolic-aldehyde component. The drying and curing operation is conveniently conducted in the presence of hot circulating air at a temperature of between about 120.degree. to 260.degree. C.

Brief Summary Text (48):

The surface-modified, strongly adherent polyester materials of the present invention are useful as reinforcing materials in the preparation of reinforced rubber-based materials such as pneumatic tires, conveyor belts, hoses, transmission belts, raincoats, and the like.

Detailed Description Text (3):

The yarn is then treated using a dip pick-up of 3.8% with a resorcinol-formaldehyde-latex (RFL) adhesive composition having the following ingredients:

Detailed Description Text (4):

The adhesive composition is prepared by adding 16.6 parts of the resorcinol to 331 parts of water, followed by the addition of 17.2 parts of formaldehyde (37%) and 2.6 parts of 50% NaOH. The resulting mixture is aged for one hour and then 245 parts of terpolymer rubber latex are added. The resulting mixture is aged for a period of 72 hours.

Detailed Description Text (6):

The adhesive characteristics of a 2-ply, 12.times.12 polyethylene terephthalate cord prepared from the yarn produced in accordance with the described procedure are determined according to a "H" adhesion test wherein a single treated cord is molded into a strip of rubber. The force which is required to pull the cord from the specimen is indicative of the degree of adhesion of the treated cord to the rubber. The specific test procedure is described more fully below.

Detailed Description Text (7):

An appropriate number of rubber strips are cut of dimension 0.375 inch by 6.5 inches. The strips are placed in mold cavities, with the polyethylene terephthalate cord placed in the mold cord slots and secured under pressure. Additional rubber strips are then placed in the mold upon the strips already present in the mold. The mold is covered with a smooth metal plate and placed in a steam heated press for curing. The mold is then removed from the press and the molded rubber stock specimen removed from the mold.

Detailed Description Text (8):

The specimen is cut to produce "H"-shaped specimens consisting of a cord with each end embedded in the center of the rubber tab on inch in length. An Instron Model 1130 tester is employed having a crosshead speed of 6 inches/minute and a gauge length appropriately sized to correspond to the size of the tab to measure the force required to separate the cord from one of the rubber ends.

Detailed Description Text (10):

The polyethylene terephthalate cord is also subjected to a standard 250.degree. F. Peel Test wherein the actual measured force and the observed adherency (using a scale of 1.0 to 5.0) is recorded. This test yields a result of 26 pounds/2.0.

Detailed Description Paragraph Table (1):

	Ingredients	Parts By Wt.
	NaOH (50%)	2.6
	Resorcinol	16.6
	Formaldehyde	
(37%)	17.2	Terpolymer rubber latex of 245 styrene/butadiene-1,2/ vinylpyridine
15/70/15 (41%)	Water	331

CLAIMS:

1. A process for the treatment of a polyethylene terephthalate material to improve the adhesion thereof in subsequent rubber-reinforcing applications comprising the steps of:

(1) activating the surface of the polyethylene terephthalate material with an electron beam from a suitable source to promote free radical formation on said material;

(2) permitting said free radicals to form hydrophilic carboxyl and hydroxyl functional groups under ambient conditions; and

(3) applying an adhesive composition which is reactive to carboxyl or hydroxyl functional groups to said material, said adhesive composition being selected from the group consisting of:

(i) multifunctional isocyanate compounds,

(ii) epoxy compounds,

(iii) mixtures of (i) and (ii), and

(iv) mixtures of (i), (ii) or (iii) with a phenolic-aldehyde latex adhesive whereby the material is suitable for reinforcing rubber.

8. The process of claim 1 wherein said polyethylene terephthalate material is in the form of a yarn which is spun into cord prior to step (1).

9. A process for the treatment of a polyethylene terephthalate filament or yarn to improve the adhesion thereof in subsequent rubber-reinforcing applications comprising the steps of:

(1) applying a spin finish to the filament or yarn;

(2) activating the surface of the polyethylene terephthalate filament or yarn with an electron beam from a suitable source to promote free radical formation on said material;

(3) permitting said free radicals to form hydrophilic carboxyl and hydroxyl functional groups under ambient conditions; and

(4) applying an adhesive composition which is reactive to carboxyl or hydroxyl functional groups to said filament or yarn, said adhesive composition being selected from the group consisting of:

(i) multifunctional isocyanate compounds,

(ii) epoxy compounds,

(iii) mixtures of (i) and (ii), and

(iv) mixtures of (i), (ii) or (iii) with a phenolic-aldehyde latex adhesive whereby the material is suitable for reinforcing rubber.

18. A process for the treatment of a polyethylene terephthalate material to improve the adhesion thereof in subsequent rubber-reinforcing applications comprising the steps of:

(1) applying an adhesive composition which is reactive to carboxyl or hydroxyl functional groups to said material, said adhesive composition being selected from the consisting of multifunctional isocyanate compounds, epoxy compounds and mixtures thereof;

(2) activating the surface of the polyethylene terephthalate material with an electron beam from a suitable source to promote free radical formation on said material; and

(3) permitting said free radicals to form hydrophilic carboxyl and hydroxy functional groups under ambient conditions whereby the adhesive composition reacts with the carboxyl and hydroxyl functional groups whereby the material is suitable for reinforcing rubber.

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L10: Entry 1 of 1

File: USPT

Apr 6, 1999

DOCUMENT-IDENTIFIER: US 5891561 A

TITLE: Power transmission belt with load carrying cordAbstract Text (1):

A component for a power transmission belt. The component is a fiber cord that is treated in a first step with at least one of a) an isocyanate compound and b) an epoxy compound such that after the first step the at least one of the isocyanate compound and epoxy compound is present in solid form in an amount equal to 0.5 to 2.0 weight %. The fiber cord is treated after the first step in a second step with an RFL liquid so that the percentage void in the cord, as determined by the following formula, is not greater than 1.5%:

Abstract Text (2):

percentage void = $100 \times \text{A.sub.y} / \text{A.sub.x}$, where A.sub.x is the total surface area of the cord and A.sub.y is the void area.

Brief Summary Text (3):

This invention relates to power transmission belts and, more particularly, to power transmission belts having load carrying fiber cords therein.

Brief Summary Text (5):

Aramid cords are being widely used as load carrying elements in power transmission belts. Aramid fiber has higher strength and a higher modulus than many other organic fibers. Aramid fiber also has excellent dimensional stability. One drawback with aramid cords being used in power transmission belts is that the cords are prone to fraying. This is particularly a problem in belts which have cut, pulley-engaging side surfaces so that the belt rubber, and the load carrying cords embedded therein, are directly exposed to cooperating pulleys in operation. This construction is typical of all types of power transmission belts, including V-belts, V-ribbed belts, and toothed belts. In this environment, the cords may also break loose from the side surfaces of the belts. Many studies have been undertaken to address this problem. Many of these studies have been specifically focused on the automotive industry, in which there is a demand for load carrying cords exhibiting good adhesion, minimal fraying, and good bending fatigue resistance.

Brief Summary Text (6):

To enhance the performance of the load carrying cords, it is known to treat the cords using resorcinol-formalin-rubber latex adhesive liquid (hereinafter RFL liquid). It is also known to pre-treat the load carrying cords with an epoxy compound, an isocyanate compound, or the like, before subjecting the cords to the RFL liquid treatment.

Brief Summary Text (7):

In Japanese Patent Publication No. H.7-72578, a cord is disclosed having initially untwisted ribbon-shaped 300-3100 denier aramid fiber filaments that are adhesive treated with a liquid that is either an epoxy or isocyanate compound. The filaments are lower twisted into strands, with two of the strands then upper twisted. The twisted strands are then either adhesive treated with rubber cement or treated with an RFL liquid followed by an adhesive treatment with rubber cement. The coefficient (X) of the upper twist is 1-4 with the coefficient (Y) of the lower twist being -1-1. The upper twist coefficient (X) and the lower twist coefficient (Y) are set in

a specific relationship to improve cohesion and improve the fraying problem.

Brief Summary Text (8):

It has been found that in using an RFL liquid treatment alone, the bending performance of the CORDS is good, but they tend to fray. It has also been found that using RFL liquid after pre-treating with an epoxy isocyanate compound tends to harden the CORD. While this improves the fraying properties, the bending fatigue resistance is unsatisfactorily diminished.

Brief Summary Text (9):

Further, by controlling the twists of the CORD components, the fraying properties have been improved, however, this alone does not make the aramid fibers suitable as load carrying members in a power transmission belt in the automotive environment. ✓

Brief Summary Text (10):

After much study by the applicant of mechanical properties of a conventionally treated CORD, it has been found that there are many voids in these CORDS. It has been determined that these voids cause fraying to occur.

Brief Summary Text (12):

In one form of the invention, a component is provided for a power transmission belt. The component is a fiber CORD that is treated in a first step with at least one of a) an isocyanate compound and b) an epoxy compound such that after the first step the at least one of the isocyanate compound and epoxy compound is present in solid form in an amount equal to 0.5 to 2.0 weight %. The fiber CORD is treated after the first step in a second step with an RFL liquid so that the percentage void in the CORD, as determined by the following formula, is not greater than 1.5%:

Brief Summary Text (13):

$\text{percentage void} = 100 \times \frac{A_{\text{sub.y}}}{A_{\text{sub.x}}}$, where $A_{\text{sub.x}}$ is the total surface area of the CORD and $A_{\text{sub.y}}$ is the void area.

Brief Summary Text (14):

The RFL liquid may be one of hydrogenated acrylonitrile-butadiene rubber latex and acrylonitrile-butadiene rubber latex.

Brief Summary Text (15):

The fiber CORD may be at least one of aramid fiber and polyparaphenylene benzobisoxazole fiber.

Brief Summary Text (16):

In one form, the fiber CORD is made up of 2-5 threads with a total denier of 300-3100, with each thread defined by twisting 100-3000 of 1-3 denier monofilaments and upper twisting the threads 4-50 times per 10 cm.

Brief Summary Text (18):

In one form, the epoxy compound is at least one of a) a reaction product of a multivalent alcohol with a halogen-containing epoxy compound and b) a reaction product with a multivalent phenol.

Brief Summary Text (19):

The RFL liquid may be made by mixing an initial condensate of formalin and resorcinol with a rubber latex that is at least one of hydrogenated nitrile rubber latex and NBR latex.

Brief Summary Text (20):

In one form, the fiber CORD is embedded in rubber as part of a power transmission belt, which rubber is at least one of hydrogenated nitrile rubber (HNBR) nitrile-butadiene rubber (NBR), chloroprene rubber (CR), chlorosulfonated polyethylene rubber (CSM) and alkylated chlorosulfonated polyethylene (ACSM).

Brief Summary Text (21):

The invention further contemplates the above CORD in combination with at least one additional component to define a power transmission belt that may be, for example, a V-belt, a V-ribbed belt, or a toothed belt. Other belt shapes and style could be

made according to the present invention.

Brief Summary Text (23):

The above described solid adhered amount of the isocyanate and/or epoxy compounds is relatively small, thereby resulting in a relatively small percentage of voids in the fiber cord. Since the solid content is small, the cord is not appreciably hardened by that solid material and as a result the bending fatigue resistance of the cord is good. The RFL liquid is used to fill a large percentage of the voids such that the cohesion of the filaments defining the cords is good. Fraying characteristics and adhesion properties of the cords may also be improved over prior art cords. The result of this may be a longer belt life compared to prior art belts.

Brief Summary Text (24):

The invention also contemplates a method of forming a cord, of the type described above, as well as a method of forming a power transmission belt incorporating the cord.

Brief Summary Text (25):

The invention further contemplates a power transmission belt having a body with a length, a width between laterally spaced sides, an inside and an outside. At least one load carrying cord is embedded in the body and extends lengthwise of the body. The cord has the construction, described above.

Brief Summary Text (26):

In one form, the sides of the belt are defined at least in part by rubber within which the cord is embedded, with the rubber being directly exposed at the sides of the belt body.

Detailed Description Text (2):

In FIG. 1, one form of power transmission belt according to the present invention, is shown at 10. The power transmission belt 10 is a V-ribbed belt. The belt 10 has a body 12 with laterally spaced sides 14, 16. The body 12 has an inside surface 18 and an outside surface 20.

Detailed Description Text (3):

A plurality of laterally spaced, load carrying cords 22 are embedded in a cushion rubber layer 24. The load carrying cords 22, which have good strength and resistance to elongation, are preferably made from aramid fiber or polyparaphenylene benzobisoxazole fiber.

Detailed Description Text (11):

In a first step, the cords 22, made from aramid and/or benzobisoxazole fibers, are treated with at least one of an isocyanate compound or an epoxy compound such that after the first step the isocyanate compound and/or epoxy compound is present in solid form in an amount equal to 0.5 to 2.0 weight %. The cord 22 is treated after the first step in a second step with an RFL liquid having hydrogenated nitrile rubber latex or nitrile-butadiene rubber (NBR) latex as a component thereof. After treatment with the RFL liquid, the percentage of voids in the cords 22 is preferably no greater than 1.5%. The percentage of voids is determined by the following formula: $\text{void (\%)} = 100 \cdot \text{times.A.sub.y} / \text{A.sub.x}$, where A.sub.x is the total surface area of the cord and A.sub.y is the void area.

Detailed Description Text (12):

It has been found that when the isocyanate compound and/or epoxy compound are present in solid form in less than 0.5 weight %, adhesion between the cords 22 and the rubber in the compression layer 26 diminishes unsatisfactorily. When the solid amount exceeds 2.0 weight percent, the cords 22 tend to harden, as a result of which their bending fatigue resistance is deteriorated.

Detailed Description Text (13):

It has also been found that if the percentage of void after the RFL liquid treatment exceeds 1.5%, the voids become relatively large and the cohesion between filaments in the cords 22 decreases. Also, the fraying problem becomes more significant.

Detailed Description Text (14):

To make the above determinations, a cord 22, treated according to the present invention, was embedded in rubber, which was then vulcanized. The proportion of void area per unit in cross section was expressed with a percentage. For the void area, a cross section of the cord 22 was enlarged with an electron microscope to allow precise area measurement.

Detailed Description Text (15):

The aramid fibers defining the cords 22 are preferably aramid fibers having aromatic rings in the main chain of the molecular structure thereof. Suitable aramid fibers are present on the market and are sold commercially under the trademarks CONEX.TM., NOMEX.TM., KEVLAR.TM., TECHNORA.TM. and TWARON.TM., and the like. The cords 22 are formed by bringing together 2-5 untwisted threads having a total denier of 300-3100, with each thread made by bundling 100-3000 1-3 denier monofilaments and upper twisting these threads 4-50 times per 10 cm.

Detailed Description Text (16):

The invention contemplates that lower twisting and upper twisting can both be carried out. However, when lower twisting is used, sometimes it becomes difficult for the RFL liquid to fully penetrate the cords 22.

Detailed Description Text (18):

A suitable epoxy compound, as described above, may be a reaction product of a multivalent alcohol such as ethylene glycol, glycerine, pentaerythritol or a polyalkylene glycol such as polyethylene glycol with a halogen-containing epoxy compound like epichlorohydrin. The epoxy compound could alternatively be a reaction product with a multivalent phenol such as a resorcinol, bis (4-hydroxyphenyl) dimethylmethane, phenol-formaldehyde resin, resorcinol-formaldehyde resin or a halogen-containing epoxy compound. The epoxy compound can be mixed with an organic solvent such as toluene or a methylethylketone. J

Detailed Description Text (19):

The RFL liquid can be made by mixing an initial condensate of formalin and resorcinol with a rubber latex that is hydrogenated nitrile rubber latex or nitrile-butadiene rubber (NBR) latex. It is preferable for improving adhesion that the mole ratio of resorcinol/formalin is in the range of 1/0.5-1/3. Then the initial condensate formalin and resorcinol are mixed 10-100 weight parts of resin per 100 weight parts of rubber, with the total solid concentration being adjusted to a concentration of 5-40%.

Detailed Description Text (20):

The above described cord 22 can be used in belt constructions other than as shown in FIG. 1. For example, the load carrying cord 22 is shown incorporated into a toothed belt 40 in FIG. 2. The belt 40 has a body 41 defining teeth 42 spaced regularly along the length thereof. The body 41 has a backside rubber section 44 in which the load carrying cords 22 are embedded. A canvas layer 46 covers the teeth 42 at the inside of the belt.

Detailed Description Text (24):

The inventive load carrying cords 22 are shown incorporated into a V-belt at 50 in FIG. 3. The belt 50 has a body 52 with a cushion rubber layer 54 in which the load carrying cords 22 are embedded. A compression rubber layer 56 is provided on the inside of the cushion rubber layer 54. Three rubberized canvas layers 58 are bonded to the outside surface 60 of the cushion rubber layer 56. Another rubberized canvas layer 62 is bonded to the inside surface 64 of the compression rubber layer 56. The laterally spaced side surfaces 66, 68 are cut and uncovered by canvas or other cloth. That is, the rubber defining the cushion rubber layer 54 and the embedded load carrying cords 22 are directly exposed at the sides of the belt body 52.

Detailed Description Text (27):

As shown in Table No. 1, 2 or 4 untwisted, 1500 denier aramid fibers (Teijin Ltd. TECHNORA.TM.) filaments were bundled together and twisted with a predetermined number of twists to define a cord.

Detailed Description Text (28):

In a first treatment step, the resulting cord was immersed in a treating liquid

having the composition identified in Table 2, below and heat treated for two minutes at 200.degree. C.

Detailed Description Text (29):

The cord was then immersed in an RFL liquid in a second treatment step, with the RFL liquid having a composition as shown in Table 3, below.

Detailed Description Text (30):

After treatment in the RFL liquid, the cord was heated for one minute at 100.degree. C. and further immersed in the RFL liquid and then heated for two additional minutes at 100.degree. C.

Detailed Description Text (32):

A cord, as shown in Table 5, below, was wound over the first rubber sheet.

Detailed Description Text (33):

A second rubber sheet, having the same thickness as the first rubber sheet, was then wound over the cord, with these components then vulcanized. A flat belt with a width of 3 mm, a thickness of 1.4 mm, and an outer peripheral length of 1000 mm was cut from the above components.

Detailed Description Text (36):

The belts were cut to a width of 2 cm and the degree of fraying of the cord exposed at the cut surface was evaluated by visual observation. The degree of fraying was identified as five levels (A to E), with A being good and E being poor.

Detailed Description Text (38):

A sample of flat belt having two cords embedded therein was aged by heating for 3 days at 140.degree. C. A bar bending test was carried out. The strength of the cord before bending and after bending 10,000 times was measured. The cord strength after bending was divided by the cord strength before bending to find the percentage strength maintenance.

Detailed Description Paragraph Table (3):

TABLE 3 _____ (weight parts) Blend D E									
_____ H-NBR Latex 100 -- NBR Latex -- 100									
Resorcinol	14.6	14.6	Formalin	9.2	9.2	Caustic Soda	1.5	1.5	Water
	262.5	262.5	Total	387.8	387.8				

Detailed Description Paragraph Table (5):

TABLE 5 _____ Inventive Embodiment Comparison									
Sample	1	2	3	4	1	2	3	Blank Cord	X X Y X X X X
First Step Treatment	RFL	Liquid	A	B	B	C	A	A	Solid Adhered Amount (wt %)
	1.7	1.7	3.7	1.8	1.7	Second Step Treatment	Liquid	D	D
	0.9	0.8	1.0	0.9	0.8	1.9	2.3	Fraying Performance	A A A A A C D (5 levels)
Maintenance	58	60	57	54	40	59	61	After Heat Aging and Bending (%)	Evaluation
	.largecircle.	.largecircle.	.largecircle.	.largecircle.	.largecircle.	x	x	x	

CLAIMS:

1. A power transmission belt comprising:

a body having a length, a width between laterally spaced sides, an inside and an outside,

there being at least one load carrying cord embedded in the body and extending lengthwise of the body,

said cord comprising fiber that is treated in a first step with at least one of a) an isocyanate compound and b) an epoxy compound such that after the first step the at least one of the isocyanate compound and epoxy compound is present in solid form in an amount equal to 0.5-2.0 weight %,

said fiber cord being treated after the first step in a second step with an RFL

liquid so that the percentage void in the cord, as determined by the following formula, is not greater than 1.5%:

percentage void = $100 \times A_{\text{sub.y}} / A_{\text{sub.x}}$, where $A_{\text{sub.x}}$ is the total surface area of the cord and $A_{\text{sub.y}}$ is the void area.

2. The power transmission belt according to claim 1 wherein the RFL liquid comprises at least one of hydrogenated acrylonitrile-butadiene rubber latex and acrylonitrile-butadiene rubber latex.

3. The power transmission belt according to claim 2 wherein the load carrying cord comprises at least one of aramid fiber and polyparaphenylene benzobisoxazole fiber. ✓

4. The power transmission belt according to claim 3 wherein the power transmission belt comprises at least one of a V-belt, a V-ribbed belt and a toothed belt.

5. The power transmission belt according to claim 4 wherein there is a canvas layer disposed on at least one of the inside and outside of the body.

6. The power transmission belt according to claim 4 wherein the body comprises rubber that is directly exposed at the sides of the body.

WEST**End of Result Set**

Generate Collection

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L9: Entry 1 of 1

File: USPT

Apr 6, 1999

DOCUMENT-IDENTIFIER: US 5891561 A

TITLE: Power transmission belt with load carrying cordAbstract Text (1):

A component for a power transmission belt. The component is a fiber cord that is treated in a first step with at least one of a) an isocyanate compound and b) an epoxy compound such that after the first step the at least one of the isocyanate compound and epoxy compound is present in solid form in an amount equal to 0.5 to 2.0 weight %. The fiber cord is treated after the first step in a second step with an RFL liquid so that the percentage void in the cord, as determined by the following formula, is not greater than 1.5%:

Brief Summary Text (3):

This invention relates to power transmission belts and, more particularly, to power transmission belts having load carrying fiber cords therein.

Brief Summary Text (5):

Aramid cords are being widely used as load carrying elements in power transmission belts. Aramid fiber has higher strength and a higher modulus than many other organic fibers. Aramid fiber also has excellent dimensional stability. One drawback with aramid cords being used in power transmission belts is that the cords are prone to fraying. This is particularly a problem in belts which have cut, pulley-engaging side surfaces so that the belt rubber, and the load carrying cords embedded therein, are directly exposed to cooperating pulleys in operation. This construction is typical of all types of power transmission belts, including V-belts, V-ribbed belts, and toothed belts. In this environment, the cords may also break loose from the side surfaces of the belts. Many studies have been undertaken to address this problem. Many of these studies have been specifically focused on the automotive industry, in which there is a demand for load carrying cords exhibiting good adhesion, minimal fraying, and good bending fatigue resistance.

Brief Summary Text (9):

Further, by controlling the twists of the cord components, the fraying properties have been improved, however, this alone does not make the aramid fibers suitable as load carrying members in a power transmission belt in the automotive environment.

Brief Summary Text (12):

In one form of the invention, a component is provided for a power transmission belt. The component is a fiber cord that is treated in a first step with at least one of a) an isocyanate compound and b) an epoxy compound such that after the first step the at least one of the isocyanate compound and epoxy compound is present in solid form in an amount equal to 0.5 to 2.0 weight %. The fiber cord is treated after the first step in a second step with an RFL liquid so that the percentage void in the cord, as determined by the following formula, is not greater than 1.5%:

Brief Summary Text (15):

The fiber cord may be at least one of aramid fiber and polyparaphenylene benzobisoxazole fiber.

Brief Summary Text (20):

In one form, the fiber cord is embedded in rubber as part of a power transmission

belt, which rubber is at least one of hydrogenated nitrile rubber (HNBR) nitrile-butadiene rubber (NBR), chloroprene rubber (CR), chlorosulfonated polyethylene rubber (CSM) and alkylated chlorosulfonated polyethylene (ACSM).

Brief Summary Text (21):

The invention further contemplates the above cord in combination with at least one additional component to define a power transmission belt that may be, for example, a V-belt, a V-ribbed belt, or a toothed belt. Other belt shapes and style could be made according to the present invention.

Brief Summary Text (24):

The invention also contemplates a method of forming a cord, of the type described above, as well as a method of forming a power transmission belt incorporating the cord.

Brief Summary Text (25):

The invention further contemplates a power transmission belt having a body with a length, a width between laterally spaced sides, an inside and an outside. At least one load carrying cord is embedded in the body and extends lengthwise of the body. The cord has the construction, described above.

Detailed Description Text (2):

In FIG. 1, one form of power transmission belt according to the present invention, is shown at 10. The power transmission belt 10 is a V-ribbed belt. The belt 10 has a body 12 with laterally spaced sides 14, 16. The body 12 has an inside surface 18 and an outside surface 20.

Detailed Description Text (3):

A plurality of laterally spaced, load carrying cords 22 are embedded in a cushion rubber layer 24. The load carrying cords 22, which have good strength and resistance to elongation, are preferably made from aramid fiber or polyparaphenylene benzobisoxazole fiber.

Detailed Description Text (11):

In a first step, the cords 22, made from aramid and/or benzobisoxazole fibers, are treated with at least one of an isocyanate compound or an epoxy compound such that after the first step the isocyanate compound and/or epoxy compound is present in solid form in an amount equal to 0.5 to 2.0 weight %. The cord 22 is treated after the first step in a second step with an RFL liquid having hydrogenated nitrile rubber latex or nitrile-butadiene rubber (NBR) latex as a component thereof. After treatment with the RFL liquid, the percentage of voids in the cords 22 is preferably no greater than 1.5%. The percentage of voids is determined by the following formula: $\text{void (\%)} = 100 \cdot \text{A.sub.y} / \text{A.sub.x}$, where A.sub.x is the total surface area of the cord and A.sub.y is the void area.

CLAIMS:

1. A power transmission belt comprising:

a body having a length, a width between laterally spaced sides, an inside and an outside,

there being at least one load carrying cord embedded in the body and extending lengthwise of the body,

said cord comprising fiber that is treated in a first step with at least one of a) an isocyanate compound and b) an epoxy compound such that after the first step the at least one of the isocyanate compound and epoxy compound is present in solid form in an amount equal to 0.5-2.0 weight %,

said fiber cord being treated after the first step in a second step with an RFL liquid so that the percentage void in the cord, as determined by the following formula, is not greater than 1.5%:

$\text{percentage void} = 100 \cdot \text{A.sub.y} / \text{A.sub.x}$, where A.sub.x is the

total surface area of the cord and A.sub.y is the void area.

2. The power transmission belt according to claim 1 wherein the RFL liquid comprises at least one of hydrogenated acrylonitrile-butadiene rubber latex and acrylonitrile-butadiene rubber latex.

3. The power transmission belt according to claim 2 wherein the load carrying cord comprises at least one of aramid fiber and polyparaphenylene benzobisoxazole fiber.

4. The power transmission belt according to claim 3 wherein the power transmission belt comprises at least one of a V-belt, a V-ribbed belt and a toothed belt.

5. The power transmission belt according to claim 4 wherein there is a canvas layer disposed on at least one of the inside and outside of the body.

6. The power transmission belt according to claim 4 wherein the body comprises rubber that is directly exposed at the sides of the body.